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On the biology of tropical spinose globigerenidae (sarcodina, foraminiferida) and its implications for paleoecology.

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SUMMARY

Although planktonic foraminifera are among the most extensively used microfossils for dating sedimentary rocks, reconstructing oceanic environments and interpreting the climate history of the past 120 million years, knowledge about the living fauna has remained scanty. Interpretation of data from new techniques and an increased demand for unraveling the ecological information contained in the fossil assemblage require detailed knowledge on living planktonic foraminifers. This was the driving force behind my work. The present thesis considers several aspects of the biology of tropical spinose globigerinids and their geological significance. The thesis is subdivided into four parts; 1) population dynamics, 2) ecological aspects, 3) modeling and 4) discussion and future research.

Part 1 considers aspects of population dynamics. Although many studies have focused on the global distributional patterns of planktonic foraminifera, information on their population structure and life cycle is sporadic. In this thesis two papers deal with the population dynamics of some spinose planktonic foraminifera. A positive correlation was found between the synodic lunar month and reproduction in some spinose planktonic foraminifers. *Globigerinoides sacculifer* (Brady) was shown to have a lunar reproduction cycle whereas *Globigerinoides ruber* (d'Orbigny) and possibly *Globigerinella siphonifera* (d'Orbigny) have a semi-lunar cycle.

In a case study on *G. sacculifer* from the Red Sea it appeared that reproduction takes place at about 80m depth and that different ontogenetic stages have a preferred depth-habitat. Phenotypes with sac-like and kummerform chambers were linked to the reproductive process.

Part 2 considers ecological aspects of planktonic foraminifera. By investigating the response of seven species of planktonic foraminifera to extreme temperatures and salinities, it was shown that temperature rather than salinity plays an important role in establishing biogeographic boundaries. On the other hand, the upper salinity limits of *G. sacculifer* and *G. ruber* could explain the opposite frequency fluctuations in late Pleistocene sediments of the Red Sea.

In combination with other indicators, test size may be used to quantify paleo-productivity. It is shown that probably because of limited respiration, symbiont bearing planktonic foraminifera attain smaller mature sizes in fertile than in oligotrophic watermasses. Also the stable carbon isotope signal is frequently taken as a productivity indicator. It could however be shown that the

primary signal is heavily influenced by a so called vital effect, i.e. biological fractionation which results in disequilibrium precipitation.

Part 3 deals with modeling. The models were designed to simulate i) foraminiferal architecture and ii) flux of planktonic foraminifers to the ocean floor.

The main parameters of shell growth, or measures derived from them, are amenable to statistical manipulation and can be used in ecologic, evolutionary and paleoenvironmental studies. Based on three premises, a model was developed that describes the architecture of some planktonic foraminiferal shells in terms of four shape parameters and two scaling factors. The effect that these shape parameters have on biologically important properties such as volume, surface area and surface to volume ratio are discussed. During growth, size increase itself has a much larger influence on the growth relationships than most of the shape parameters. This observation emphasizes the role of size during foraminiferal development. Only the ratio of the volume between consecutive chambers was shown to influence the volume to surface ratio to some extent. The other shape parameters only provide a fine tune up of the growth relationships.

A new method is presented to calculate volumes and surface areas of geometric structures by means of the computer bit-space. This technique enables us to estimate these properties in actual planktonic foraminifers.

Sediment traps have been used to measure foraminiferal shell flux to the ocean floor. A computer model was developed in order to investigate the influence of the timing of shell catch relative to the lunar cycle and the total collecting time of individual sediment trap cups. The sampling effects are exemplified by net-collected samples of *G. sacculifer* from the Red Sea. It is shown that the onset of the trap sampling does not influence the catch in this respect as long as the deployment time equals the reproductive cycle or is a multiple of it. It is also shown that the flux of *G. sacculifer* shells to the ocean floor is not a steady shell rain but a pulsating flux with a maximum around full moon.

Part 4 demonstrates the geological significance of aspects of my research according to the principle "the present is the key to the past", discusses projects that are presently being carried out and future research.

INTRODUCTION

Foraminifera ar
Rhizopodea), which is
pseudopodia. Other re
Heliozoa. The shape
mineralized shell distir
Granuloreticulosia is ic
network and comprise
order Athalamida. W
chambered) and the F
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species are thus classi

The most rece
assigned to about 300
1988). Most Foraminif
the geological record,
Tappan (1988) recogn
of extant species bet
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Foraminifera h
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have a lamellar wall
the evolution of mod